Radiation and You - Outline - Middle School Presentation

1. INTRODUCTION QUESTIONS HANDOUT

¾ radiation safety specialist at LLNL
¾ will talk about radiation & radioactivity
¾ give you some "hands-on" experience
¾ clear up common misconceptions

2. RADIOACTIVITY AND RADIATION - what is radioactivity?

¾ why are some atoms radioactive?
¾ what is radiation? 2a. ALPHA RANGE - FIESTA WARE
¾ what are some types of radiation? 2b. BETA RANGE - FIESTA WARE
¾ how does radiation interact with matter?

3. SOURCES OF RADIATION - have you ever been exposed to radiation?

¾ natural background 3a. CLICKS ON GM or µR meter
¾ medical 3b. Do X-RAYS MAKE YOU Radioactive?
¾ miscellaneous (consumer, nuclear power)

4. EFFECTS OF EXPOSURE TO RADIATION - what does radiation do to you?

¾ what are the effects of exposure?
¾ acute effects 4a. HULK COMIC BOOD
¾ risks of CA

5. USES OF RADIATION - can you give me an example of how radiation is used?

¾ medicine, research, industry
¾ use in consumer products 5a. WHICH ARE RADIOACTIVE?

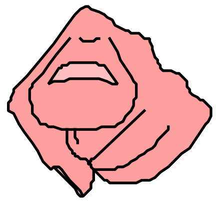
6. WORKING SAFELY WITH RADIATION - how do we work safely with radiation?

¾ precautions geared to how much & what type
¾ radiation vs. contamination
¾ design of buildings
¾ protective clothing 6a. ANTI-C/BANANA demonstration
¾ dosimeters 6b. TLDs - HOT PLATE demonstration

7. SUMMARY - What have we learned?

¾ radiation & radioactivity are well understood
¾ we are all continuously exposed to low levels of radiation (Nat. Bkgd & med.)
¾ health effects depend upon how much radiation and in what time frame
¾ risks of low level exposures are low compared to other risks
¾ radiation is widely used in medicine, research, & industry
¾ now you are more informed about radiation & radioactivity

Questions About:



Radiation and You

1. Why are some materials (like uranium) considered to be radioactive while others (like pepperoni pizza) are not?

2. Is it true that bananas are radioactive? (Does this have anything to do with how King Kong got to be so big?)

3. Why are airline flight attendants exposed to more radiation than the average person? Does it have anything to do with airline food?

4. Do the thin "radiation" suits worn by some nuclear power plant workers really protect them against radiation? If so, then why do reactor buildings have to use a lot of concrete radiation shielding?

5. If alpha particles can be stopped by a piece of ordinary paper (this is true) why is plutonium (which emits mostly alpha radiation) potentially very hazardous?

6. How can radiation both cure cancer and cause cancer?

7. Why does the dental hygienist leave the room while you are getting x-rays? Does he or she know something that you don't?

8. If you break your arm and get an x-ray at the doctor's office, does your arm become radioactive? Maybe for just a few minutes?

9. Is everything that "glows in the dark" radioactive? Do all radioactive materials glow in the dark? Do any radioactive materials glow in the dark??

10. What do "Wint-O-Green" Lifesavers have to do with questions #9?

11. Is your teacher radioactive? Is the person sitting next to you radioactive??!

12. Are you being exposed to radiation while you are reading these questions?

(See other side for answers)

Answers

1. All uranium atoms have an excess amount of energy and undergo radioactive decay sooner or later. Therefore, all isotopes of uranium are considered to be “radioactive”. Although almost all materials (even the ingredients of a pizza) have very small quantities of naturally occurring radioactive materials (mostly potassium-40, some uranium and thorium) they are not usually considered to be “radioactive”.

2. Technically yes, because bananas contain the element potassium, and a very small fraction of that potassium is the naturally radioactive isotope potassium-40. However, the quantity of radioactivity is so small that you would need a very special and sensitive radiation detector in order to measure it.

3. The earth’s atmosphere provides a good deal of shielding from cosmic rays. Jet airliners fly at very high altitudes - above much of the atmosphere. The dose rate from cosmic rays at these altitudes is higher than the dose rate at sea level. Flight crews spend many hours a day in this higher radiation field, and therefore receive an additional radiation dose of 100 to 200 millirem each year.

4. The thin paper or cloth suits worn by some nuclear power plant workers are “anti-contamination” suits, not “anti-radiation” suits. The purpose of the suits is to keep contaminated dust or dirt off of the worker. Such protective clothing does not provide any shielding against typical radiation fields in a nuclear plant.

5. Radioactive elements (like plutonium) that emit alpha particles can present a hazard if they are taken into the body by inhalation or by mouth. If plutonium gets inside the body, the emitted alpha particles deposit their energy directly into tissues and cells, causing damage.

6. Radiation affects the body by depositing energy into cells and into molecules that make up cells. If a lot of energy (a high radiation dose) is deposited, the cell is killed, and cannot go on to reproduce a cancerous group of cells. If a smaller (sub-lethal) dose is deposited, the cell may just be damaged and may eventually cause cancer. (The cell may also be able to repair itself, in which case no damage or cancer will occur.) Thus, a very large dose may be used to destroy most or all of the cells in a tumor. A much smaller dose may just damage cells, and these may later become cancerous.

7. The dental hygienist is using good radiation protection practices in keeping his or her dose as low as possible. If the hygienist stayed in the room with you, he or she would be unnecessarily exposed to scattered radiation from the X-ray machine. By simply stepping out of the room (or around the corner) the hygienist eliminates this unnecessary exposure.

8. Objects (and people) do not become radioactive when exposed to X-rays. Although some of the energy of the X-ray beam is deposited in your bones ;and tissues, this energy does not make your body radioactive.

9. Not everything that glows in the dark is radioactive, in fact most radioactive materials do NOT glow in the dark. Fireflys give off light that is produced by a chemical (not nuclear) reaction. Radioactive materials (like radium) can be mixed with other materials (like zinc-sulfide) to produce a mixture which glows in the dark.

10. If you suddenly break or crush “Wint-O-Green” lifesavers in a dark room, you will be able to see tiny blue-green flashes of light. This phenomenon, called “triboluminescence” is caused by the release of energy stored in the crystal structure of the life saver.

11. Technically, everyone is a little radioactive because of the potassium-40 in our bodies. Each of us emit several hundred gamma-rays every second!

12. Yes, you are being exposed to natural background radiation even as you are reading this sentence (ZAP!). This background radiation comes from radon decay products in the air we breathe, from cosmic rays, from uranium and thorium in the rocks and soils (ZAP!), and from other naturally occurring radioactive materials (mostly potassium-40) found in our (ZAP!) bodies.

Watch It, Dude!
That Stuff's Radioactive!

All atoms are made up of neutrons, protons, and electrons, The neutrons and protons are located in the center ("nucleus") of the atom. This nucleus is surrounded by a "cloud" of orbiting electrons.

The number of protons in an atom determine what chemical element that atom is. For example, every atom with 6 protons is a CARBON atom. Every atom with 19 protons is a POTASSIUM atom.

Atoms of the same element can have different numbers of neutrons. Such atoms are called ISOTOPES of the element. For example, most potassium atoms have 19 protons and 20 neutrons, but some potassium atoms have 19 protons and 21 neutrons.

The atoms of some isotopes are "unstable", that is, they have an excess amount of energy. These atoms get rid of this excess energy by throwing out small packets of energy or mass called RADIATION. Atoms which emit RADIATION are said to be "RADIOACTIVE."

After the atom has given off it's radiation, it is changed into an atom of a different chemical element! For example, after a potassium-40 atom emits a gamma-ray, it changes into an atom of the element argon!

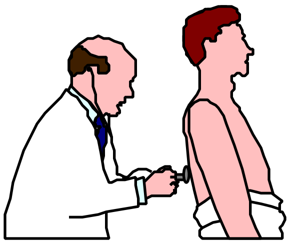
You are being exposed to Radiation while you read this page!

We are all being exposed to very low levels of nuclear radiation all of the time! Everybody in the world is exposed to NATURAL BACKGROUND RADIATION. This radiation comes from RADON (from uranium in the soil) COSMIC RAYS, naturally-occurring radioactive materials (mostly potassium-40) inside our bodies, and directly from URANIUM AND THORIUM in the ground.

On the average, we each get about 300 to 400 "millirem" of radiation DOSE every year. Most of this dose comes from natural background radiation. This chart shows you where this radiation comes from.

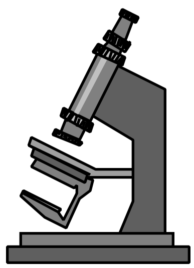
Examples of Applications of Radiation

Medical:



- ¾ Diagnostic X-rays (dental X-rays, CAT scans, mammograms, etc).
- ¾ Therapeutic (Co-60, accelerators for cancer treatments).
- ¾ Diagnostic nuclear medicine (liver function tests).
- ¾ Therapeutic nuclear medicine (1-131 for thyroid cancer treatment).
- ¾ Nuclear thermoelectric-powered heart pacemakers.

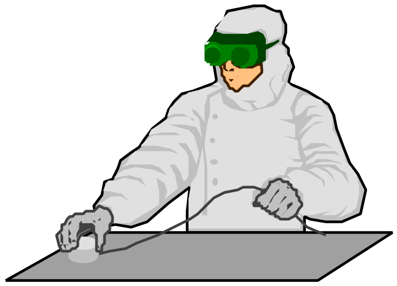
Research:



- ¾ X-ray diffraction (study of molecular structure - e.g. DNA structure).
- ¾ Isotopic tracers (biomedical research - e.g. C-14 to study photosynthesis).
- ¾ Accelerators (nuclear structure, materials analysis).
- ¾ Electron microscopes.

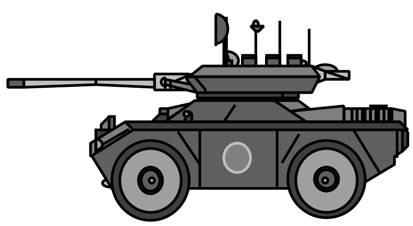
Consumer Products:

- ¾ Cathode ray tubes (TVs, computer monitors).
- ¾ Smoke detectors.
- ¾ Emergency lighting.
- ¾ Static eliminators.
- ¾ Luggage screening systems. (X-ray and neutron activation).



Industrial:

¾ Sterilization (of medical materials & supplies).
¾ Insect eradication (release of insects sterilized by irradiation).
¾ Food preservation.
¾ Process control (density gauges).
¾ “Curing” of plastics.
¾ Commercial nuclear reactors.
¾ Isotopic electric power sources (satellites, spacecraft).
¾ Industrial radiography (verification of welds & structures).
¾ Ion implantation (semiconductor industry).
¾ Electron beam applications (e.g. vacuum deposition)



National Defense:

¾ Nuclear weapons.
¾ Strategic defense (X-ray lasers, particle beams, etc.)

A Summary of the
Biological Effects of Ionizing Radiation

- Ionizing radiation can cause biological damage by depositing energy into the cells that make up the organs and tissues of our bodies.

- This deposited energy (the radiation "dose") can damage important biological molecules (like DNA) that help cells work properly.

- The overall effects of exposure to ionizing radiation depend upon

  ¾ the total **AMOUNT** of deposited energy (the total "dose"),
  ¾ the **TIME PERIOD** in which this radiation dose is received, and
  ¾ what **PORTIONS or ORGANS** of the body are exposed to the radiation

  ❖ **VERY HIGH RADIATION DOSES** (doses greater than about 100,000 millirem) can cause serious illness, injury, and even death.

  ❖ **MODERATE RADIATION DOSES** (roughly 10,000 to 50,000 millirem) do not cause any immediate health effects, but do increase the risk of getting cancer or leukemia later in life. The risk is assumed to be proportional to the dose; i.e., the higher the dose, the higher the risk.

  ❖ The effects of **LOW RADIATION DOSES** (below about 10,000 millirem) are too small to measure. Most radiation scientists assume that low doses of radiation may cause an increased risk of getting cancer or leukemia later in life.

- Radiation can also cause "**genetic effects** ". That is, people who are exposed to radiation can have an increased risk of having children with birth defects. However, there has been no indication of genetic effects in human populations.

- Despite what you have seen in the movies, and Teenage Mutant Ninja Turtles notwithstanding, radiation does NOT:

  ¾ turn people into INCREDIBLE HULKS
  ¾ turn people into SPIDERMAN (SPIDER-PERSONS)
  ¾ create Giant Insects, Spiders, Reptiles, etc.
  ¾ make people glow in the dark
  ¾ turn people into cannibalistic zombies

Risky Business?

Each of the following activities
increases your risk of death by one chance in one million

Activity	**Cause of Death**
10 millirem of radiation (typical chest X-ray)	Cancer
About 20 days of breathing (radon “daughters” in air)	Lung cancer (from radiation dose to lungs)
Smoking 1 cigarette	Cancer, heart disease
Drinking 1/2 liter of wine	Cirrhosis of the liver
Spending 2 days in New York or Boston	Air pollution
Rock climbing for 1 1/2 minutes	Fatal accident
Traveling 6 minutes by canoe	Fatal accident
Traveling 10 miles by bicycle	Fatal accident
Traveling about 45 miles by car	Fatal accident
Flying 1000 miles by jet airplane	Fatal accident
Living 2 months with a cigarette smoker	Cancer, heart disease
Eating 40 teaspoons of peanut butter	Cancer caused by alfatoxin B
Drinking Miami drinking water for 1 year	Cancer caused by chloroform
Drinking 30 cans of diet soda	Cancer caused by saccharin
Eating 100 charcoal-broiled steaks	Cancer caused by benzopyrene

How do these risks compare? How do you weigh the risks versus the benefits of each of these activities? Would you change your life-style to avoid or reduce some of these risks?

Information adapted from:

Pochin, E.E., “Why be Quantitative about Radiation Risks?”, Lauriston Taylor Lecture Series in Radiation Protection and Measurements, Lecture 2. National Council on Radiation Protection and Measurements, Washington DC, 1978.

Cohen, B.L., Lee, I.SW., “A Catalog of Risks”, Health Physics 36:707-727, Pergamon Press, 1979.

Wilson, R. “Analyzing the Daily Risks of Life”, Technol. Rev. Vol 81, No 4, p. 40, 1979